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Image Processing and Computer Vision Algorithms for Sustainable Shellfish Farming

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***Abstract*— As the global human population increases, the demand for food will increase also. One area of particular interest to help meet this demand is the aquaculture industry. Shellfish such as oysters can be farmed rather than caught in the wild, allowing for increased yield and streamlined harvesting. However, like many other agricultural industries, these fields lack the technological advancements needed to meet the global demand for food crops. By utilizing deep learning and high-performance computing models can be made to help classify and monitor oyster farms. These and other advancements will allow the field of oyster farming to become increasingly efficient and sustainable. This project will use Python to create an algorithm capable of detecting, classifying, and monitoring oysters to allow for the automation of oyster farms. By utilizing data containing different images of oysters under multiple states of activity a convolutional neural network will be trained to achieve high accuracy in classifying oyster activity. In addition to providing advancements in this field, the results of this research can be applied to the Chesapeake Bay oyster research to help increase the overall health of the Bay and the species living in it.**

***Index Terms*—Algorithms, Networks, Oyster, Shellfish, Farming, Learning, USDA, GPU, HPC**

# I. Introduction

As the global demand for seafood increases it will continue to outpace the rate at which these goods are harvested in the wild. To meet this requirement the use of farming is needed. However, currently, these farms have suboptimal practices that have much room for improvement using technological advancements found in other fields. Mainly, this project will employ both deep learning computer vision and classification algorithms to measure the activity of oysters. The measurements of activity can then be used to find the ideal time to harvest the oyster “crop” [1].

The United Nations Food and Agriculture Organization (FAO) currently ranks the United States as having high potential growth in this sector. By using these systems, the practice of oyster farming can be made more sustainable. As these farming processes become more efficient, they will be able to help meet the increasing demand for food. Additionally, the advancements made through this project can be applied to oyster populations in various bodies of water. The data collected using these systems can be used to monitor the health of wild oyster populations. Using this information, actions can be taken to increase the health of oyster populations, therefore increasing the overall health of the area [2]. Due to the previous work in this field, these systems could have particularly meaningful use applications in the Chesapeake Bay [3].

The model for this project will be a convolutional neural network also known as a CNN. This algorithm extracts data from input images and then uses a traditional neural network to classify the data. The network will learn to extract the right features and classify the input correctly using a training stage. This stage will feed the network images with a label that the network will use to alter its structure. When the training process is complete the resulting network will be able to generalize the process, classifying images it has never seen before [4]. A CNN was chosen for this project due to its high accuracy in image classification and ability to extract data from images without human intervention.

# II. Objectives

This project seeks to create a deep learning model that can identify and classify oyster activity. This model will be able to monitor the oysters to detect their level of interaction and measure their adaptation to the environment. When complete this classification model will allow for remote inventory and monitoring of oyster crops, streamlining the process of oyster farming.

# III. Methods

## Design

This project will use Python to implement a convolutional neural network to detect, classify, and monitor oysters. This network will be able to localize oysters within an image and classify their current activity. By repeatedly doing this process the health and adaptation to the environment of each oyster can be measured. Thus, once complete this system will allow the process of oyster farming to become more efficient and automated, increasing the total production of each farm.

One difficulty in the implementation of this project is finding a collection of data containing images of oysters. Collecting data underwater is particularly difficult and time-consuming. Currently, there are no freely available datasets with these images. Consequently, this project may require the manual creation of a dataset with a sufficient number of images to train a network. To compile this dataset images of oysters will be cropped from images and placed into categories based on their activity level.

An additional challenge that must be overcome is the difficulty of processing underwater images. Underwater images contain a wide variety of different aspects that make them difficult to process. From oysters being blocked by cloudy or dark water to being covered by objects, the process of looking for oysters in these conditions is extraordinarily difficult [5]. To solve this issue, different image processing techniques may need to be used. Once the images are properly processed the training process can be started [6].

## Procedure

To train this network datasets containing samples of closed, partially opened, and fully opened oysters will be used. As stated previously the network will be implemented in Python using deep learning libraries. Optimization libraries will also be used to ensure the model has high accuracy when classifying the states of activity. After the model has been adequately trained its accuracy will be tested on real-world data. The results of this testing data will be used to refine the model to achieve the highest reasonably achievable accuracy. Once the algorithm is complete the results of the research will be compiled into a final report paper discussing the findings of the study.

# IV. Schedule

Weeks 1-2: Reading material and spending time becoming familiar with required software.

Weeks 3-8: Design and implementation of the algorithms and model.

Week 9-10: Refining algorithms, collecting data, and writing the final report.

Each Friday the group will meet with the faculty mentor to go over the current progress and the plans for the next week.

# VI. References

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1. The paper was written for the NSF REU Exercise 2022 [↑](#footnote-ref-1)